RESTRICTED CIRCULATION

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Agricultural Memorandum No 441

The "Growing Season" at Eskdalemuir Observatory, Dumfriesshire

(55° 19' N. 03° 12' W. 242 m above MSL)

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Introduction

In temperate climates it is a conventional practice to define a "growing season" as that period of the year when mean temperature (sometimes relating to shallow depths in the soil, but more generally in the air at the standard height of 1.3 m (4 ft) from the ground) exceeds 5.6°C (42°F). Although the growth of a wide range of indigenous species cannot be too closely linked with a particular level of mean temperature, experience shows that the "growing season" so defined is a useful crude parameter for evaluating the impact of climate on many phases of agricultural production.

The increasing interest in the agricultural potential of the hill areas and the possibility of climatic variations on a scale of decades of years having a significant impact upon agriculture, renders an analysis of the "growing season" a matter of some interest. For this exercise data from Eskdalemuir Observatory 1914–1970 (1972) have been examined.

Data and Procedures

From the readily available week-by-week averages of mean daily air temperatures, the day of the year (D_1) in which the level of mean temperature rose above 42°F and that (D_2) on which it fell below 42°F were estimated from a smooth curve drawn through the weekly values. In some years values oscillated about 42°F before being sustained above (or below) this threshold; in such cases an estimate, subjectively derived from the run of the curve was adopted: transient excursion of the temperature above 42°F occurring either very early or very late in the year were ignored when defining the passage of the curve through the threshold value.

The sequence of values of D_1 and D_2 are plotted in Figs 1. In Fig 2 that of L (the length of the "season") and in Fig 3 the associated length of the "non-growing" season. In Fig 4 is given a scatter diagram showing the relationship between D_1 and the mean temperature for the month of April. Statistical parameters for D_1, D_2 and L, for 1914–20 and subsequent decades 1921–30 etc to 1961–70 are set out in Table 1.

Discussion

(i) From 1914 to about 1930 and from 1962 to 1971, the date of the beginning of the "season" varied between about April 10 (day 100) to April 30 (day 120): in the intervening period it fluctuated widely, and in 10 of the years (most markedly in 1938, 1945, 1948, 1957, 1959 and 1961) it occurred in the month of March. These dates are shown as anomalies in Fig 4: further examination of these cases revealed a one-to-one correspondence between the dates and a monthly mean March temperature $\geq$40.5°F.

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The need for caution in projecting any apparent trend into the future is clearly shown by the values of D_1 for the 1971 and 1972 (see Fig 1).

Decadal means are set out in Table 1. The fortuitous effect of selecting any particular period for averaging is well illustrated by the contrast between the mean value for 1961-70 and that given by a 10-year period 1962-1971 (mean D_1 being respectively 100 and 104).

(ii) The date of the end of the season (D_2) has fluctuated far less widely than has D_1: in most seasons this occurs between October 24 (day 297) and November 16 (day 320).

(iii) The length (L) of the season (see Fig 2) necessarily reveals the wide fluctuations in the 1936-61 period compared with the steadier behaviour prior to and subsequent to, these years: furthermore the experience of long seasons (240 days or more) from late 1930's to early 1960's should not necessarily be regarded as typical on a long term basis. It should also be noted that during this last mentioned period years occurred when the commencing date was as late, and the season as short as more frequently experienced prior and subsequent to them. The effect of a very anomalous year 1938 on the value of the standard deviation of L for the 1931-40 decade (see Table 1) underlines the need for caution when using this parameter for statistical estimation.

(iv) In Fig 3 the data has been set out in terms of the length of the non-Growing Season. The 160(+) days prior to 1935-36, the more frequent shorter "winter" season from that date to 1960/61 and the more recent run of rather longer winters is evident.

(v) The arithmetic process of deriving a date such as D_1 or D_2 from the run of a mean temperature ($\overline{T}$) necessarily implies a close association between the date and the value of T. We have however derived D_1 from the run of <u>weekly</u> means and the relationship between D_1 and a <u>monthly</u> mean is of some interest. A plot of D_1 against mean monthly temperature for April is given in Fig 4 together with a free-hand best fitting curve.

There is a fairly satisfactory relationship between the date of D_1 (spanning the period March 25 to May 5) and the mean temperature for April unless the mean monthly March temperature was $\geq 40.5^{\circ}F$: in all such cases and only in such cases the beginning of the season will occur in March and a mean of $43.5^{\circ}F$ or more appears to be associated with a "Growing Season" beginning in early March.

(vi) To what extent the indications of the Eskdalemuir results can be regarded as representative for a substantial area of Scotland requires further investigation. However it is a matter of experience that maps of the "temperature anomalies" (based upon mean monthly values) show a broad scale coherent pattern over substantial areas, hence arguing from Fig 4 the year-to-year fluctuation in D_1 (also D_2 and L) may be expected to be indicative of the experience over a wide area.

Secondly, a current parallel examination of the Growing Season in south Norway from 1943 to date reveals the same contrast noted in Fig 1 between pre and post 1961 behaviour.

Conclusions

Some tentative conclusions are as under:-

(i) The date of the commencement of the Growing Season at Eskdalemuir is considerable more variable than that of the end of the season.

(ii) The frequent early dates of the beginning of the "season" experienced in the 1936-61 period, and the associated prolonged seasons are not typical of pre-1936 nor of the post-1962 eras. Alternatively expressed, the non-Growing ("winter") seasons prior to 1936 and since 1961/2 have tended to be longer and more frequent than in the intervening years.

(iii) The date of commencement of the Growing Season is closely related to the mean temperature in the month of April, except that when, and only when, the mean March temperature exceeds about 40.5°F - in this case the season commences in March and possibly in early March.

Table 1. "Growing Season" at Eskdalemuir 1914–1970.

Decadal and period values of mean date of beginning of Season (D_1); of end of season (D_2) and length of season (L), together with range and standard deviation.

Period	D_1			D_2			L		
	Mean value	Range	SD	Mean value	Range	SD	Mean value	Range	SD
1914–20	19/4	8/4–4/5	7	4/11	21/10–22/11	13	199	184–217	12
1921–30	21/4	3/4–4/5	10	30/10	17/10–15/11	8	192	173–217	12
1931–40	11/4	3/3–27/4	16	3/11	19/10–22/11	11	206	175–264	25
1941–50	6/4	11/3–29/4	15	4/11	23/10–17/11	8	213	184–243	19
1951–60	8/4	16/3–30/4	18	9/11	19/10–19/11	9	215	187–248	19
1961–70	10/4	1/3–24/4	15	4/11	27/10–14/11	6	209	195–250	17
1914–1940	17/4	3/3–4/5	13	2/11	17/10–22/11	11	199	173–264	19
1941–1970	8/4	1/3–30/4	16	6/11	19/10–19/11	8	212	184–250	19

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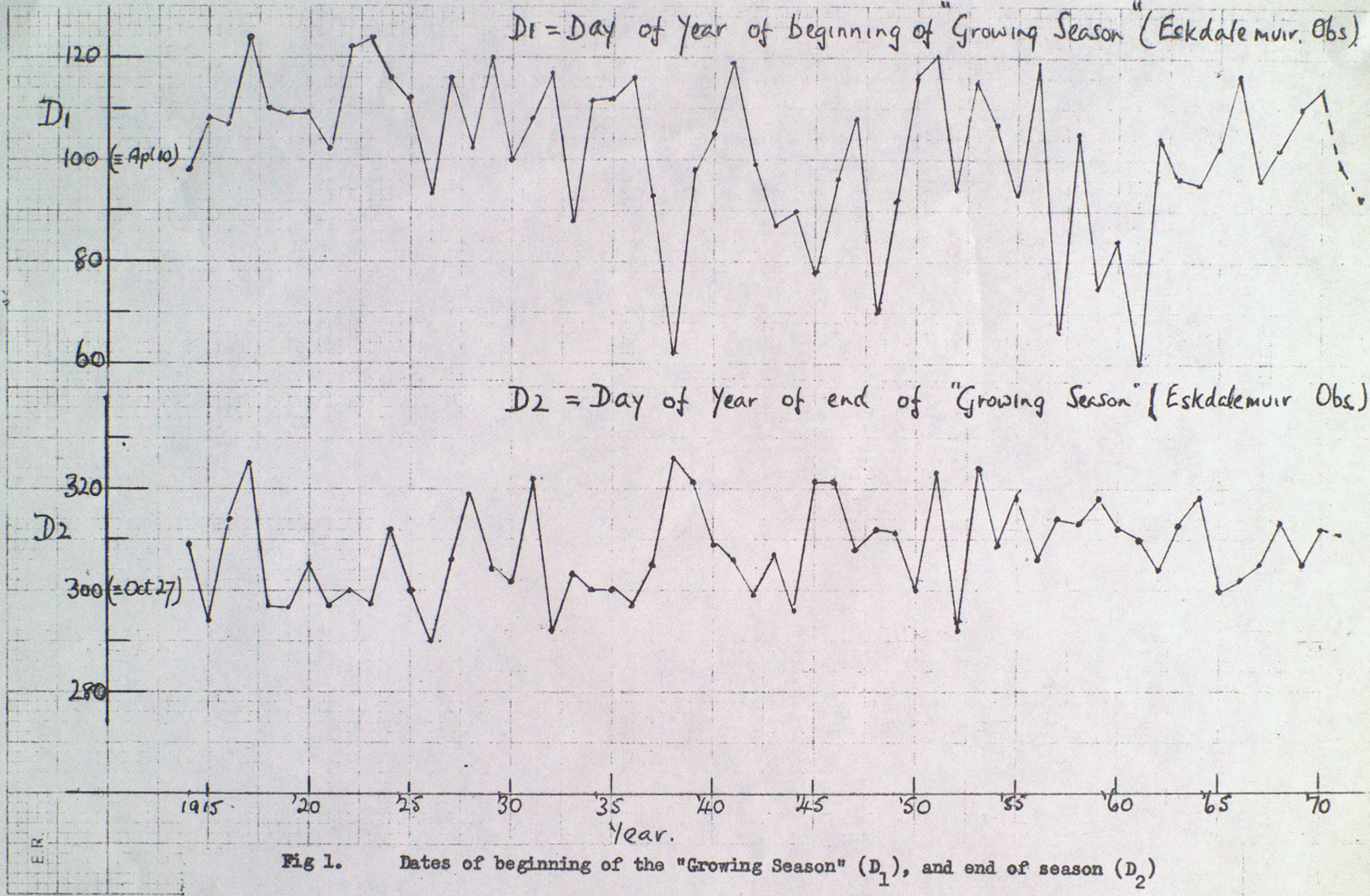

Fig 1. Dates of beginning of the "Growing Season" (D_1), and end of season (D_2) at Eskdalemuir Observatory.

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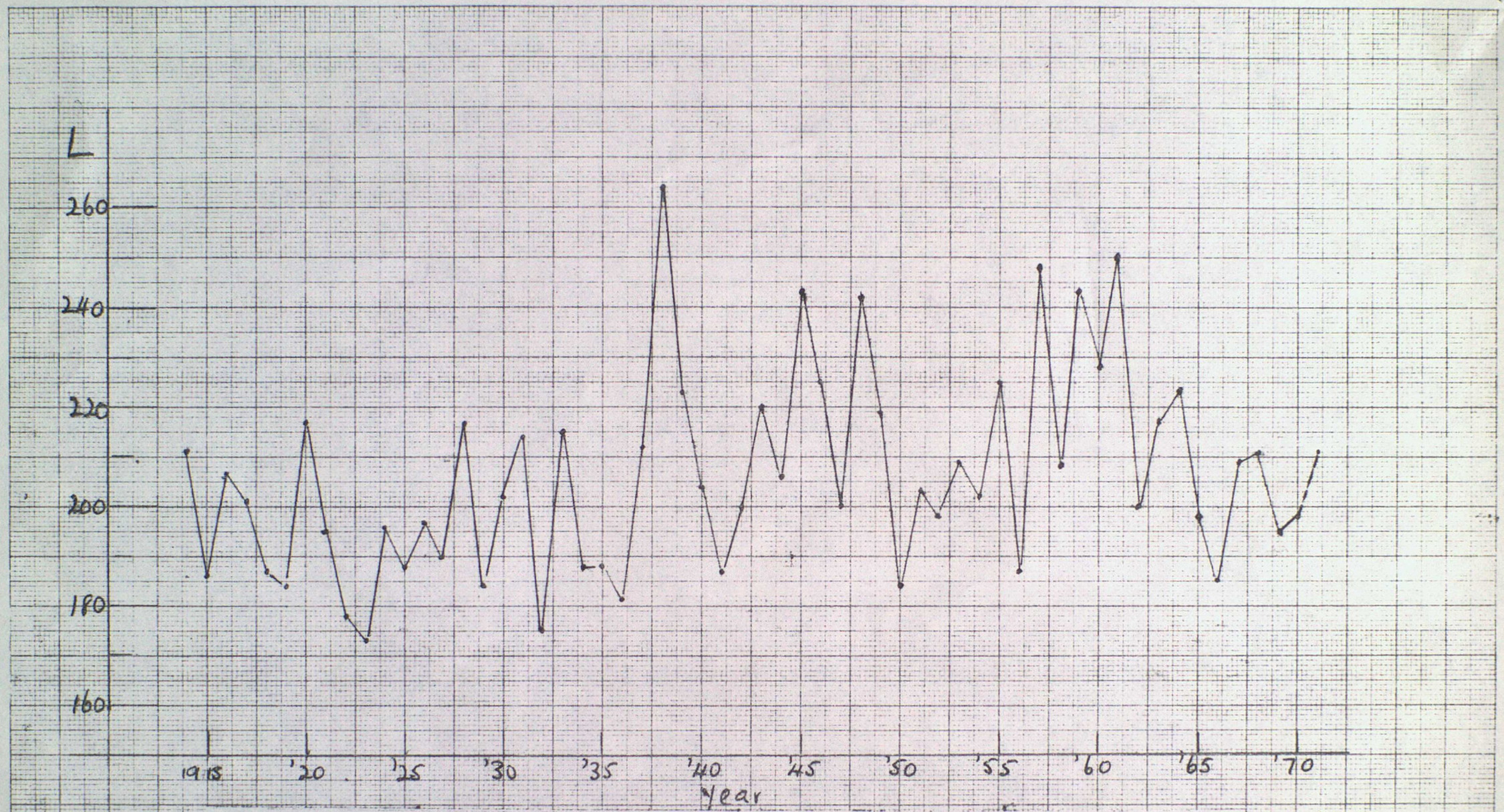

Fig 2. Length (in days) of the "Growing Season" at Eskdalemuir Observatory.

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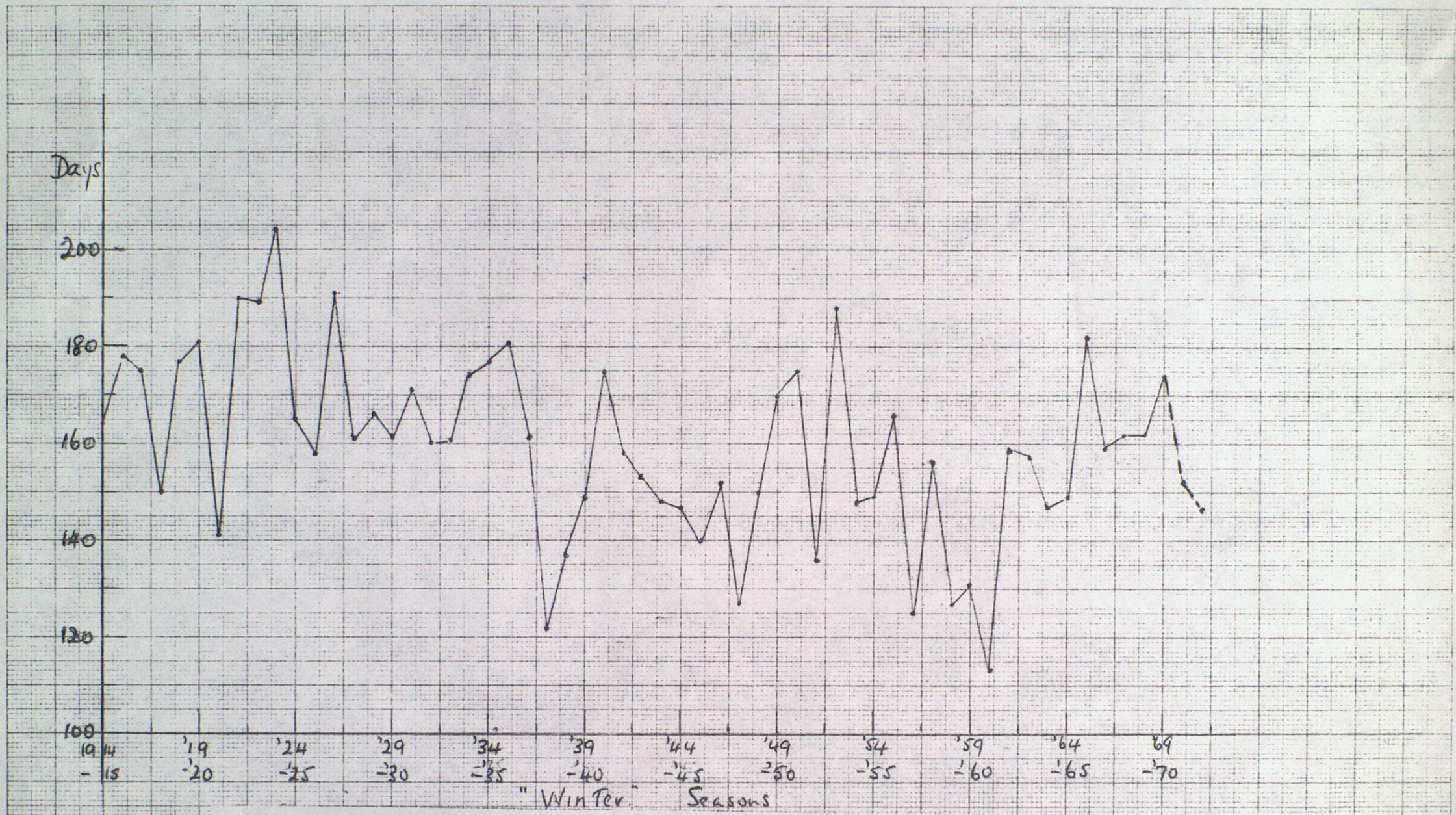

Fig 3. Length (in days) of the "non-Growing Season" at Eskdalemuir Observatory.

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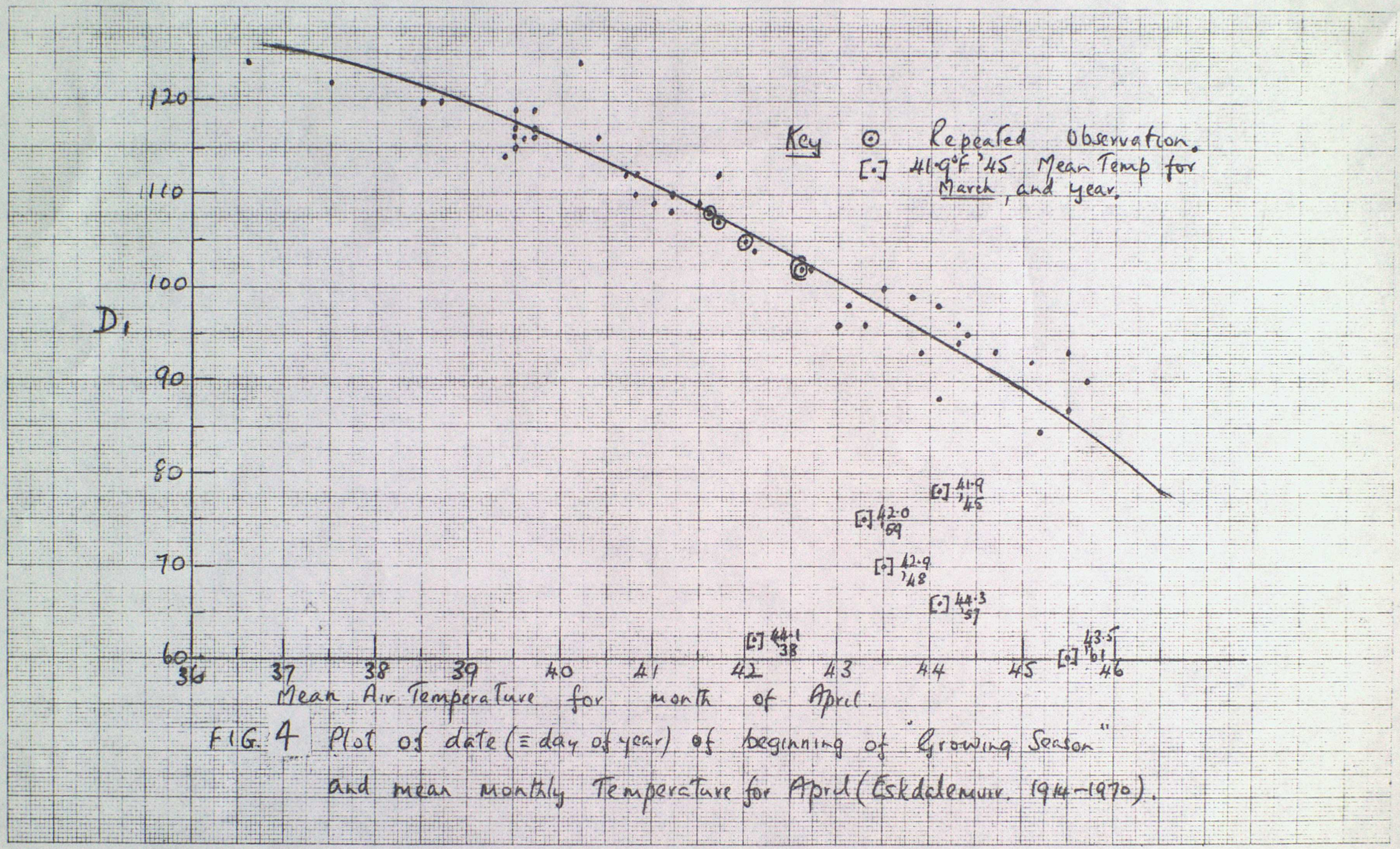

FIG. 4 Plot of date (≡ day of year) of beginning of "Growing Season" and mean monthly Temperature for April (Eskdalemuir, 1914–1970).